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Supplemental Information

Novelty-Sensitive Dopaminergic Neurons in the Human Substantia Nigra Predict Success of Declarative Memory Formation

Jan Kamiński, Adam N. Mamelak, Kurtis Birch, Clayton P. Mosher, Michele Tagliati, and Ueli Rutishauser

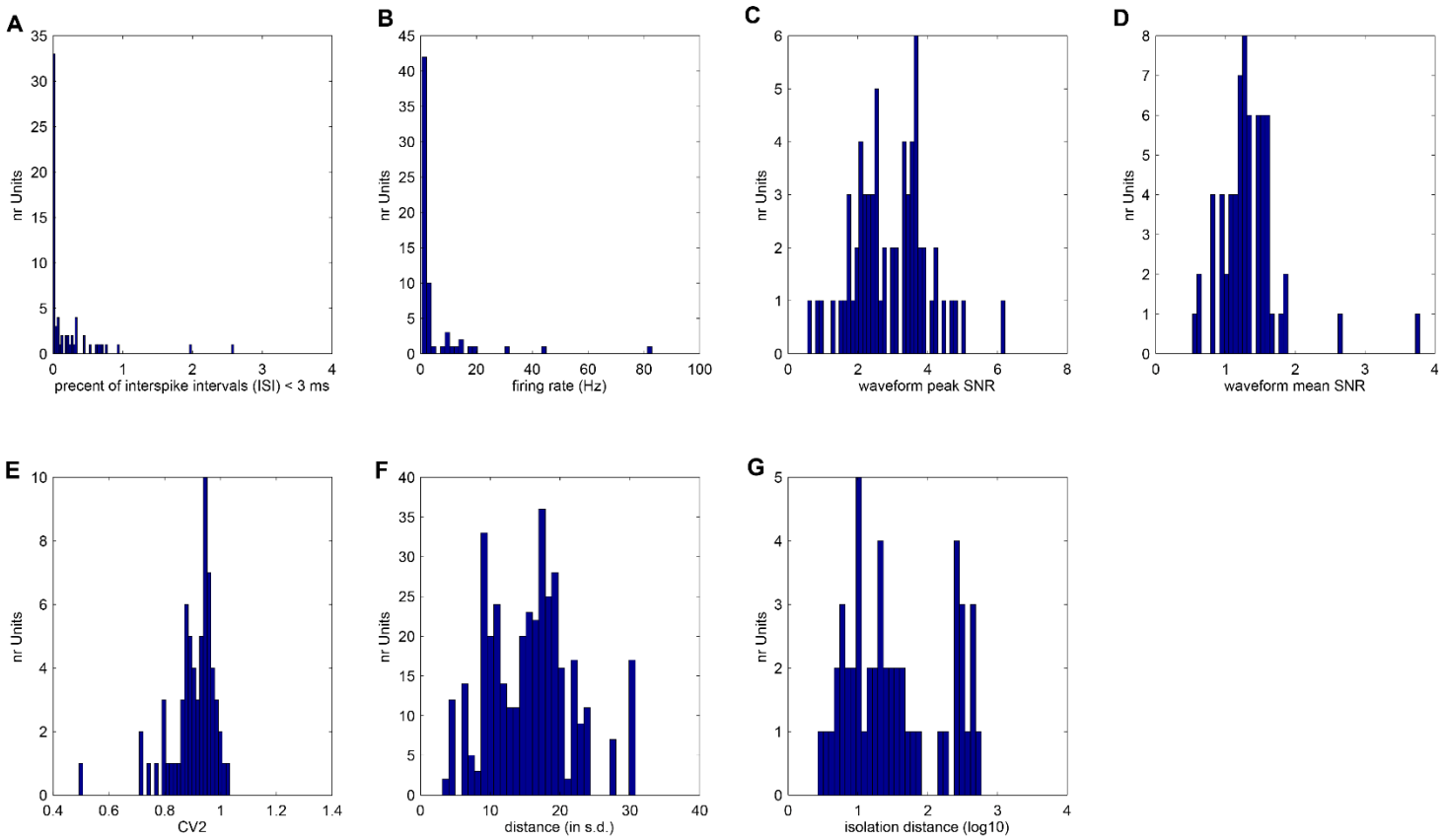

Figure S1. Spike-quality metrics for all identified putative single-cells (clusters). Related to STAR Methods - *Spike sorting and quality metrics of single units*

(A) Histogram of proportion of inter-spike intervals (ISIs) that were shorter than 3ms. The large majority of clusters had less than 0.22% of such short ISIs. (B) Histogram of average firing rate. (C) Histogram of the singal-to-noise ratio (SNR) of the peak of the mean waveform. (D) SNR of the whole waveform of all units. (E) Histogram of coefficient-of- variation (CV2) values for every neuron. (F) Pairwise distance, estimated using the projection test, between clusters where more than one unit was found on one wire. (G) Isolation distance for all units for which this metric was defined (mean = 102.2).

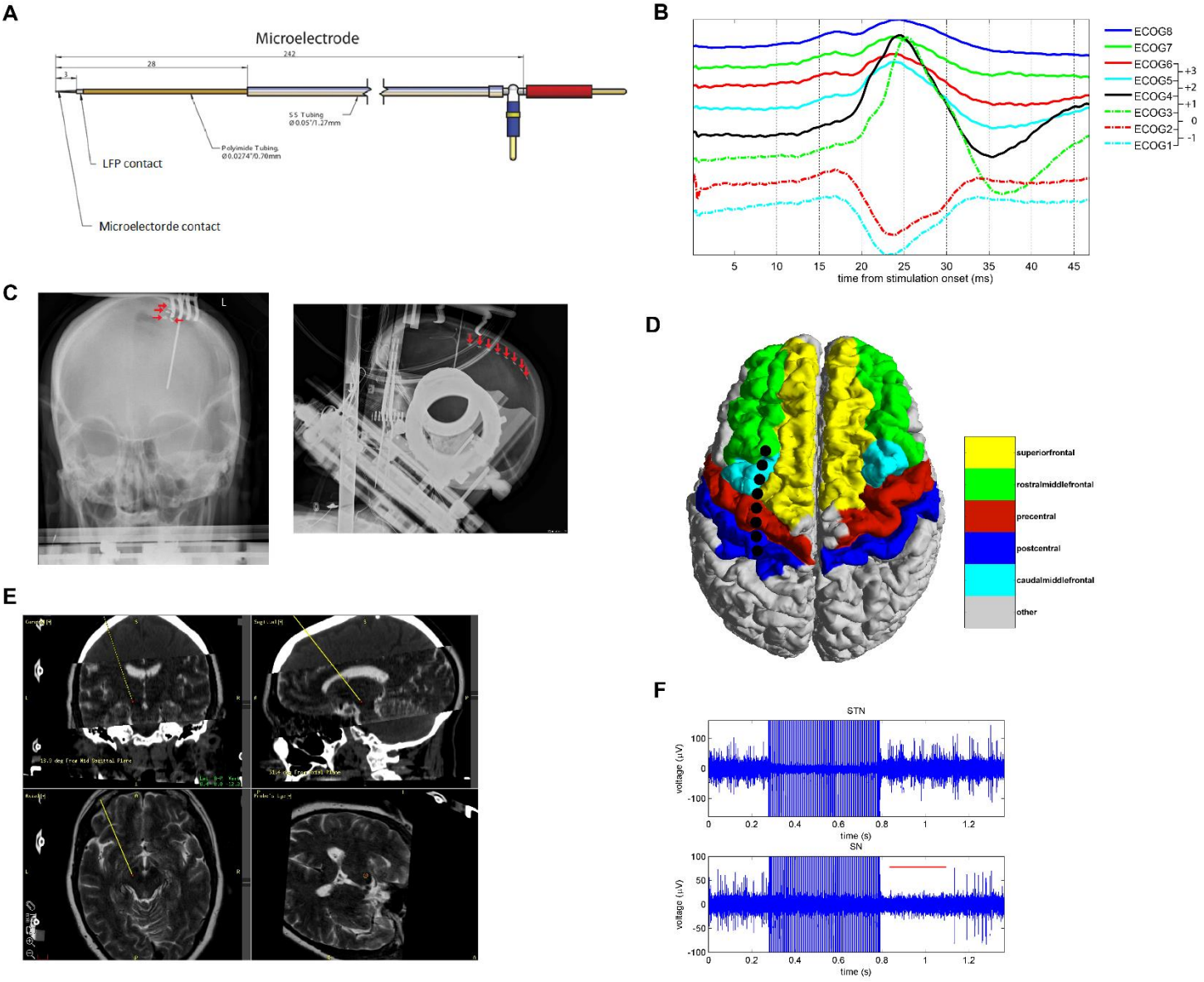

Figure S2. Recording locations. Related to STAR Methods - *Localization of electrodes*

(A) The hybrid microelectrode used. (B) Example evoked potentials aligned to time of median nerve stimulation pulse onset (t=0). An inversion of the potential can be observed between electrodes 2 and 3. This electrode pair (2-3) was labeled as "central sulcus 0" for analysis. (C) Intraoperative AP and lateral X-ray of a patient with an implanted ECoG strip. Recording contacts are marked with red arrows. (D) ECoG electrode positions as determined using X-ray images shown superimposed on a FreeSurfer-based cortical surface reconstruction. This reconstruction used the pre-operative MRI scans of the patient. Shown is an individual example from patient 2. (E) Screenshots from the Medtronic StealthStation system used during surgical planning. Yellow lines show trajectory used. The red dot represents the recording location. (F) Example microelectrode recording during electrical micro stimulation of STN and SN. Low amplitude (10 μA) stimulation transiently suppressed activity in SN but not in STN for several hundred ms after the end of the stimulation period (marked in red).

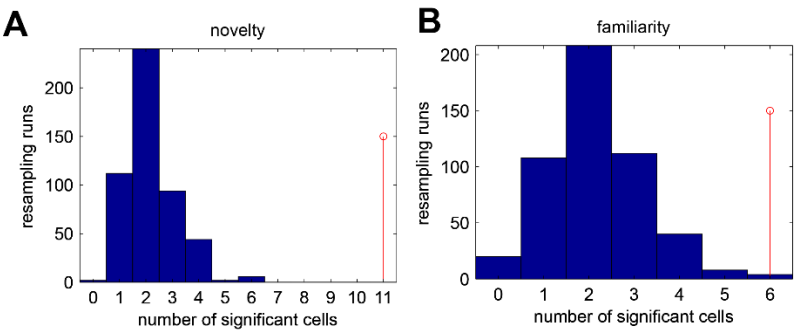

Figure S3. Resampling statistics for number of memory selective cells selected. Related to Figure 3
Estimate of chance values (null distribution) of number of cells observed (blue) compared to the actual number of cells found (red). The null distribution (blue) was estimated by re-running the identical selection procedure after first randomly permuting the order of the labels assigned to each trial. The p-value is equal to the number of chance observations (blue) which are larger than that observed (red). In cases where no chance values exceeded those observed, we set p-values to 1/B with B the number of resampling runs (B=500). (A) significance of the number of novelty neurons (P=0.002). (B) significance of the number of familiarity neurons (P=0.002)

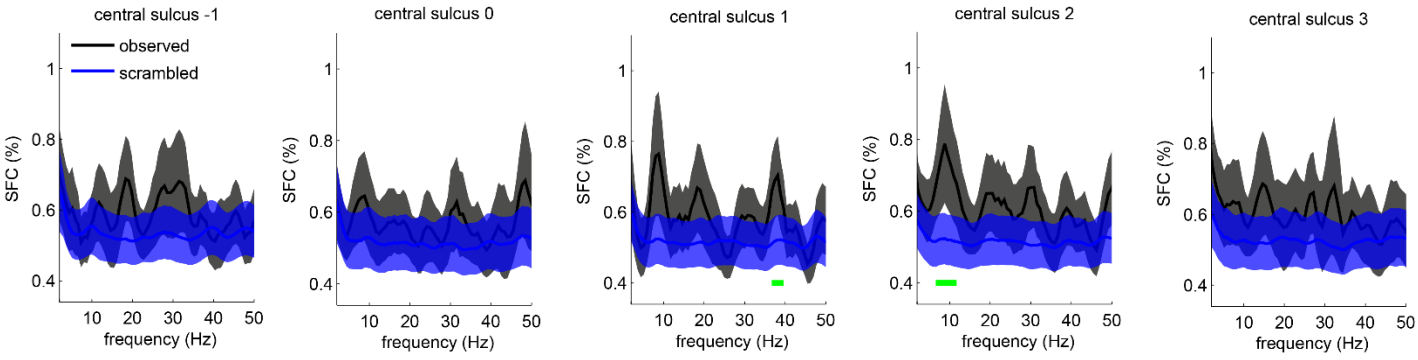

Figure S4. SFC of all neurons recorded in SN with respect to cortical ECoG signals across all contacts. Related to Figure 4
Data are compared with the SFC expected by chance (black), which was estimated by advancing times randomly (repeated 500 times, corrected for multiple comparisons using a cluster-size correction, see STAR Methods)

Id	Side of Surgery	Age	Sex	PD duration	UPDRS III Off/On	DRS Total (out of 144)	DRS MEM (out of 25)	BVMT Recog (out of 6)	HVLT Recog (out of 12)
5	L and R	71	M	10	40 / 22	142	24	6	9
6	L	55	F	4	na / na	na	na	na	11
8	L	65	M	8	Na / 24	na	na	na	na
11	L and R	69	F	8	42 / 36	na	na	na	na
12	L and R	55	F	15	17 /7	142	24	5	12
17	R	65	M	ET	Na / na	na	na	na	na
18	R	58	M	11	41 / 15	141	24	6	6
22	R	67	M	3	10 / na	144	25	6	7
23	L	80	F	ET	na / na	na	na	na	na
24	L	67	M	7	40 / 14	139	21	6	9
25	L	75	M	na	na / 24	na	na	na	na
27	L	64	M	11	33 / 16	143	25	6	9
30	L	70	M	6	33 / na	na	na	na	na
32	R	54	M	21	na / 57	na	na	na	na
35	R	73	M	11	31 / 12	143	25	6	12
36	L	75	M	12	na / 21	136	23	4	11
39	L	65	M	9	32 / 12	142	25	4	6
41	L and R	47	M	5	na / 25	na	Na	na	na
42	L	53	M	6	na / 22	143	25	6	11
43	L and R	70	M	10	46 / 27	141	25	6	10
45	L	54	M	14	na / 16	na	na	na	na
59	L	69	M	11	36/12	na	na	na	na
61	R	61	M	3	na	na	na	na	na
		64.4		**9.3**		**141.5**	**22.2**	**5.1**	**8.7**

Table S1. List of patients. Age and duration of PD is at the time of recording. Related to STAR Methods - Experimental Model and Subject Details

Two patients were diagnosed with essential tremor (ET) and not PD. DRS scores are from the Mattis Dementia Rating Scale-2. BVMT is the Brief Visuospatial Memory test. HVLT is the Hopkins Verbal Learning Test. “na” indicates scores not available because the patient was not asked to perform this particular test. The last row shows averages. Averages only include available values.